

REMARKS

REJECTION UNDER 35 U.S.C. §102 OR §103

In the Office Action, at pages 2-3, numbered paragraphs 2-3, claims 5-6 are rejected under 35 U.S.C. §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious in view of Fauteux et al. (USPN 5,217,827; hereafter "Fauteux"). This rejection is traversed and reconsideration is requested.

As an increasing number of electronic systems are powered by batteries, battery life has become a primary design consideration. To maximize battery life, system designers have needed to develop an understanding of the capabilities and limitations of the batteries that power such systems and to incorporate battery considerations into the system design process. Research has shown that the amount of energy that can be supplied by a given battery varies significantly, depending on how the energy is drawn. Hence, new approaches are being implemented to achieve battery life improvements over conventional low-power design techniques.

It is respectfully submitted that there are many different types of electrochemical cells. Electrochemical cells comprise two electrodes, an anode and a cathode, that have different electrode potentials so that an electric current may be generated. The cathode receives electrons and provides a surface for a reduction reaction. The anode gives up electrons and provides a surface for an oxidation reaction.

Fauteux teaches an electrochemical cell having a *lithium anode* and a cathode that is a composite of an insertion compound, an electronically conductive filler and a polymer electrolyte. Thus, Fauteux utilized an early attempt to use lithium metal in combination with a transition metal oxide, sulfide or selenide intercalation (insertion) compound. These cells, although exhibiting the high energy densities expected, suffered from two main problems, caused mainly by the lithium anode: limited cycle life and poor safety. The lithium anode causes both the poor safety and limited cycle life. During repeated discharge and charge cycles, the lithium stripping and replating process is not 100% efficient, and this creates a high surface area, particulate lithium which gradually consumes the lithium metal foil anode. The presence of particulate lithium causes increased internal resistance that limits the cycle life. In addition, and more importantly, the particulate lithium creates major safety problems and

renders the cell unsafe (col. 2, lines 1-60). Thus, at the anode of Fauteux, the oxidation reaction is: $\text{Li} \rightarrow \text{Li}^+ + \text{e}^-$. The lithium ions migrate to the insertion cathode of Fauteux where the reduction reaction is: $\text{Li}^+ + \text{e}^- \rightarrow \text{Li}$. That is, the Li anode is dissolving and is converted to lithium metal at the cathode until sites at the cathode become clogged or inactive, making them unavailable for further use.

In contrast, claim 1 of the present invention, and the other independent claims, in similar fashion, recite a lithium negative electrode (a cathode), wherein liquid lithium metal is coated on a metal current collector, a positive electrode (anode), a separator between the anode and cathode, and an electrolyte comprising a lithium salt and organic solvents, wherein the electrolyte is contained in the anode, cathode and the separator. Thus, where the anode is Li_2S , the oxidation reaction at the anode for the present invention is: $\text{Li}_2\text{S} \rightarrow 2\text{Li}^+ + \text{S} + 2\text{e}^-$ (i.e., S^{2-} is oxidized to S, and the Li^+ remains in solution). At the cathode, the reduction reaction is $\text{Li}^+ + \text{e}^- \rightarrow \text{Li}$. In the present invention, at the anode, the Li_2S is gradually dissolved, and the lithium ions migrate to the cathode, where the lithium ions are converted to lithium metal that is plated onto the cathode.

It is clear that the oxidation-reduction pairs of reactions for Fauteux and the present invention as claimed are different. Thus, the electrochemical cells of Fauteux and the claimed present invention are different, and perform differently. As is known to those skilled in the art, while sites at the cathode of Fauteux become clogged with lithium so that the cathode eventually becomes unusable, the cathode of the claimed present invention simply obtains a plating of lithium metal, and continues to function as desired. At the anode of Fauteux, the lithium anode is dissolved (being oxidized), whereas at the anode of the present invention, lithium sulfide or the like is dissolved, and lithium is not oxidized.

When the oxidation-reduction reactions for an electrochemical cell are different, the electrochemical cells behave differently. Thus, it is respectfully submitted that the electrochemical cell/battery of Fauteux is different from, and does not anticipate the electrochemical cell/battery of claim 5 of the present invention under 35 U.S.C. §102(b). Since claim 6 depends from claim 5, claim 6 is submitted to be allowable under 35 U.S.C. §102(b) over Fauteux for at least the reasons that claim 5 is submitted to be allowable under 35 U.S.C. §102(b) over Fauteux.

The choice of different oxidation-reduction reactions is critical for an electrochemical battery, and individual selections of oxidation-reduction reactions cannot be effectively generalized. Thus, the choice of lithium metal as an anode is not suggestive of the choice of lithium metal as a cathode, and it is respectfully submitted that claim 5 of the present invention is not taught or suggested by Fauteux under 35 U.S.C. §103(a). Since claim 6 depends from claim 5, claim 6 is submitted to be allowable under 35 U.S.C. §103(a) over Fauteux for at least the reasons that claim 5 is submitted to be allowable under 35 U.S.C. §103(a) over Fauteux.

REJECTION UNDER 35 U.S.C. §103

In the Office Action, at pages 3-4, numbered paragraphs 3-4, claims 5, 2-3, 6 and 19 are rejected under 35 U.S.C. §103(a) as being unpatentable over Koksbang (USPN 5,411,763; hereafter, "Koksbang") in view of Nishijima et al. (USPN 6,534,214; hereafter, "Nishijima"). This rejection is traversed and reconsideration is requested.

Claims 5 and 19 of the present invention have been amended to recite: "wherein the lithium battery retains 90% or greater of a capacity at a fiftieth charging and discharging cycle as compared to a capacity at a first charging and discharging cycle."

As noted above, claim 5 of the present invention teaches a lithium cathode, and the oxidation-reduction reactions of the claimed present invention are then different from an invention such as Koksbang, which teaches a lithium anode. Hence the electrochemical cells/battery of claim 5 of the present invention is different from the electrochemical cell/battery of Koksbang. Different electrochemical cells/batteries behave differently, and selection of one set of oxidation-reduction reactions for an electrochemical cell/battery does not suggest that another selection of oxidation-reduction reactions would behave similarly. Thus, it is respectfully submitted that claim 5 of the present invention is not taught or suggested by Koksbang under 35 U.S.C. §103(a). Since claims 2-3 and 6 depend from claim 5, claims 2-3 and 6 are submitted to be allowable under 35 U.S.C. §103(a) over Koksbang for at least the reasons that claim 5 is submitted to be allowable under 35 U.S.C. §103(a) over Koksbang.

Claim 19 of the present invention describes a method of manufacturing a lithium battery in accordance with claim 5. It is respectfully submitted that claim 19 is allowable under

35 U.S.C. §103(a) over Koksbang for at least the reasons that claim 5 is submitted to be allowable under 35 U.S.C. §103(a) over Koksbang.

Although Nishijima teaches metallic lithium as a negative electrode material, Nishijima fails to teach a positive electrode including a binder, wherein the positive electrode comprises a positive active material selected from the group consisting of elemental sulfur, solid Li_2S_n ($n \geq 1$), Li_2S_n ($n \geq 1$) dissolved in catholyte, organo-sulfur, and a carbon-sulfur polymer $((\text{C}_2\text{S}_x)_n$, wherein $x=2.5 - 50$, $n \geq 2$), as is recited in amended claims 5 and 19.

There is no teaching or suggestion of combining Koksbang and Nishijima, and even if combined, there is no teaching or suggestion of utilizing a lithium negative electrode together with a positive electrode including a binder, wherein the positive electrode comprises a positive active material selected from the group consisting of elemental sulfur, solid Li_2S_n ($n \geq 1$), Li_2S_n ($n \geq 1$) dissolved in catholyte, organo-sulfur, and a carbon-sulfur polymer $((\text{C}_2\text{S}_x)_n$, wherein $x=2.5 - 50$, $n \geq 2$), as is recited in amended claims 5 and 19.

The genius of invention is often a combination of known elements which in hindsight seems preordained. To prevent hindsight invalidation of patent claims, the law requires some "teaching, suggestion or reason" to combine cited references. Gambro Lundia AB v. Baxter Healthcare Corp., 110 F.3d 1573, 1579, 42 USPQ2d 1378, 1383 (Fed. Cir. 1997). When the art in question is relatively simple, as is the case here, the opportunity to judge by hindsight is particularly tempting. Consequently, the tests of whether to combine references need to be applied rigorously. See In re Dembiczak, 175 F.3d 994, 999, 50 USPQ2d 1614, 1617 (Fed. Cir. 1999), limited on other grounds by In re Gartside, 203 F.3d 1305, 53 USPQ2d 1769 (2000) (guarding against falling victim to the insidious effect of a hindsight syndrome wherein that which only the inventor taught is used against its teacher).

It is respectfully submitted that the courts have held that the Examiner may not suggest modifying references using the present invention as a template absent a suggestion of the desirability of the modification in the prior art. *In re Fitch*, 23 U.S.P.Q.2d 1780, Fed Cir. 1992. Something in the prior art as a whole must suggest the desirability, and thus, the obviousness, of making the combination. *Alco Standard Corp. v. Tennessee Valley Authority*, 808 F. 2d 1490, 1 U.S.P.Q. 2d 1337 (Fed. Cir. 1986). When a rejection depends on a combination of prior art references, there must be some teaching, suggestion or motivation to combine the references. *In re Geiger*, 815 F.2d 686, 688 2 U.S.P.Q.2d 1276, 1278 (Fed. Cir. 1987). Thus, since there is

no teaching or suggestion of combining Koksbang with Nishijima, it is respectfully submitted that claims 5 and 19 are patentable over Koksbang in view of Nishijima under 35 U.S.C. §103(a).

Since claims 2-3 and 6 depend from amended claim 5, claims 2-3 and 6 are submitted to be allowable over Koksbang in view of Nishijima under 35 U.S.C. §103(a) for at least the reasons that amended claim 5 is submitted to be allowable over Koksbang in view of Nishijima under 35 U.S.C. §103(a).

REJECTION UNDER 35 U.S.C. §112

In the Office Action, at page 5, numbered paragraph 4, claim 19 is rejected under 35 U.S.C. §112 as being indefinite.

Claim 19 has been amended to recite "... ~~the~~ a liquid lithium metal," and is now submitted to be definite.

CONCLUSION

In accordance with the foregoing, claims 5 and 19 have been amended. No new matter is being presented, and approval and entry are respectfully requested.

Claims 2, 3, 5, 6, 8-17 and 19 are pending and under consideration. Claims 8-12, 16 and 17 are allowed. Reconsideration is respectfully requested.

In accordance with the foregoing, it is respectfully submitted that all outstanding objections and rejections have been overcome and/or rendered moot, and further, that all pending claims patentably distinguish over the prior art. Thus, there being no further outstanding objections or rejections, the application is submitted as being in condition for allowance which action is earnestly solicited.

If the Examiner has any remaining issues to be addressed, it is believed that prosecution can be expedited by the Examiner contacting the undersigned attorney for a telephone interview to discuss resolution of such issues.

If there are any underpayments or overpayments of fees associated with the filing of this Amendment, please charge and/or credit the same to our Deposit Account No. 19-3935.

Respectfully submitted,
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